REMARKS

By the present amendment, claim 1 has been amended to be presented with separate paragraphs.

Claims 1-2, 4-5, and 7-19 are pending in the present application.

In the Office Action, claims 1-2 and 19 are rejected under 35 U.S.C. 102(e) as anticipated by US 6,901,747 to Tashiro et al. ("Tashiro").

Further, claims 4, 7-8, 12-13, and 15 are rejected under 35 U.S.C. 103(a) as obvious over Tashiro, and claims 5, 9-11, 14, and 16-18 are rejected under 35 U.S.C. 103(a) as obvious over Tashiro in view of US 6,082,325 to Digeser et al. ("Digeser").

Reconsideration and withdrawal of the rejections is respectfully requested. It is submitted that the Office refers to an embodiment of Tashiro with plural pilot injections and to another embodiment of Tashiro with pilot injection ahead of the TDC, namely, the fourth and the second embodiment, respectively, of Tashiro, but these embodiments are completely separate and they are not combinable, and in any case, any combination of these embodiments according to Tashiro would not result in the presently claimed invention.

More specifically, the Office Action refers to the passage of Tashiro at col. 8, lines 32-40 and col. 9, lines 28-35, as allegedly illustrating multiple pilot injections triggered from approximately 50 to 5 degrees ahead of the TDC. The Office Action also refers to Fig. 5A and col. 8, lines 45-48, and col. 14, lines 28+ as allegedly illustrating a main injection triggered up to approximately 35 degrees after the TDC.

However, the passage at col. 8, lines 32+ of Tashiro refers to the <u>fourth</u> embodiment of Tashiro described at col. 16, lines 59+ and illustrated on Fig. 7 of Tashiro, in which there are plural pilot injections but they are timed at or later than the TDC as shown on Fig. 7 of Tashiro. In particular, Tashiro states at col. 8, lines 40-44 that the timing of the pilot injections is “at a timing allowing the ignitionability, and the combustion flame is sustained until the injection timing of the main injection.” This corresponds to the detailed description of the fourth embodiment illustrated on Figs. 7-8 of Tashiro, in which there are plural pilot injections, but these multistage injections are “retarded”, which means that the first of the multistage pilot injections is “at a timing ts1 near the top dead center (TDC),” so as to “permit ignitionability” (Tashiro at col. 17, lines 5-10). It is noted that, in this fourth embodiment with multistage pilot injections, Tashiro mentions adjusting the number of pilot injections and the fuel quantity, but not the timing range of the pilot injections (see Tashiro at col. 17, lines 41-51).

In contrast, Figure 5 of Tashiro corresponds to the <u>second</u> embodiment of Tashiro described at col. 14, lines 20+ and illustrated on Fig. 5 of Tashiro, in which the pilot injection may be ahead of the TDC as shown on Fig. 5, but there is only one pilot injection. Thus, the corresponding description of Tashiro systematically refers to "the pilot injection" (see Tashiro at col. 14, line 20+). Further, in this second embodiment, Tashiro adjusts the injection quantity “Vp” of the single pilot injection Fp (see Tashiro at col. 15, lines 57-61) but there is never more than a single pilot injection.

In summary, in the second embodiment, Tashiro uses a single pilot injection that may be timed ahead of the TDC, and in the fourth embodiment, Tashiro uses multistage pilot injections, but the pilot injections are at or after the TDC.

The reasons for these embodiments in Tashiro are as follows. The main objective of Tashiro is the regeneration of a particle filter (PF) (see, e.g., Tashiro at col. 11, lines 3-6). The PF regeneration requires the combustion, for example, every 500 miles (the mileage between two regenerations depends on the type of driving conditions, city or highway, etc.) of the carbon or soot accumulated in the PF. The PF regeneration requires a high temperature (650 degrees C, or 550 degrees C if means for lowering the combustion temperature of the soot are used, for example, by providing an additive in the fuel or by a catalytic impregnation of the PF material.

To reach this temperature sufficient for the combustion of the soot accumulated in the PF, a commonly used option is to increase the temperature of the exhaust gases from the engine. To this effect, the fuel injected into the cylinders must not be completely converted into work during the combustion, but a portion must be transformed into heat. This transformation into heat occurs when the fuel injection is late. This is what is described in Tashiro (see, e.g., Tashiro at col. 8, lines 32+).

However, if there was a single late injection, this fuel would not burn because there would be insufficient "ignitionability" (Tashiro at col. 8, line 42). Thus, an injection that is less late (i.e., a pilot) is necessary to make the ignition possible. However, if the main injection must be late but the pilot injection must not be late, there remains a "gap" between this pilot and the main injection, and during this "gap," the ignition becomes insufficient to ensure a satisfactory

combustion of the main injection. Therefore, continuity of the ignitionability is ensured by a series of pilot injections distributed in the "gap" (see Tashiro at col. 8, lines 42-44: "the combustion flame is sustained until the injection timing of the main injection").

This explains why, in the fourth embodiment of Tashiro, the later the main injection, the later also the pilot injection or injections, so as to sustain "ignitionability."

Turning to the second embodiment of Tashiro, Tashiro teaches adjusting the "retard Rm" of the main injection, and in this embodiment, the pilot injection is adjusted accordingly by modifying the "injection quantity Vp" (see Tashiro at col. 14, lines 46-52 and Figs. 5(b) and (c)). More specifically, the amount injected in the pilot injected is increased so as to avoid "misfire" of the main injection Fm (Tashiro at col. 14, line 55). The pilot injection is timed so that "the fuel of the pilot injection Fp can be burned securely near the top dead center" (Tashiro at col. 15, lines 62-63).

In contrast, in the presently claimed invention, at least two pilot injections are triggered in a crankshaft angle range from approximately 50° to approximately 5° ahead of the top dead centre point of the cylinder concerned, and a main injection is triggered in an undercalibrated range up to a crankshaft angle of approximately 35° after the top dead centre point, as recited in present claim 1.

An advantage of these features of the presently claimed features is that it makes it possible to improve the regeneration of a NOx trap. Generally, an NOx trap is regenerated at a very different rate than a particle filter (PF), for example, regeneration during 2 seconds every 60 seconds. Further, in an NOx trap, regeneration does not correspond to combustion of

accumulated soot as in a PF, but it involves desorption of NOx through a chemical reaction (see, e.g., Fig. 2 of the present application). This reaction does not necessarily require a high temperature like the regeneration of the PF. Rather, it is often advantageous to limit the regeneration temperature to avoid a deterioration of the mechanical properties (see, e.g., the present specification at page 4, lines 6-7). However, the chemical reaction requires a rich mixture, i.e., with a stoichiometry preferably slightly above 1 (but advantageously close to 1 because, if the mixture is too rich, H_2S may be produced). When the mixture is rich, it has a lower O_2 content, so that CO is produced rather than CO_2, this CO being a preferred reducer (see, e.g., the present specification at page 4, lines 1-2).

Thus, an option to increase the richness and obtain CO is to perform an incomplete combustion via a main injection that is late, and in this case, a "gap" as discussed above is not necessarily a problem, because, in the case of NOx trap regeneration, an incomplete combustion can be rather advantageous, and incomplete combustion can be promoted by a degraded ignitionability of the main injection.

In addition, if multiple pilot injections are provided that are not late, they are converted into work and thus ensure a satisfactory operation of the engine. For example, it is possible to superpose well-concentrated jets at lower pressure that will burn better than a single jet of a larger quantity of fuel that is sent at higher pressure and may hit the chamber walls without burning. These advantages are explained in the present specification, for example, at page 4, lines 24-29 ("the strategy employing two pilot injections therefore satisfies the NOx trap criteria since it significantly reduces combustion instabilities at those points, because of the phasing of

the two pilot injections, reduces noise, also because of the phasing of the two pilot injections…") Of course, another advantage of the multiple pilot injections at that timing is that it can allow the injection to be timed and adjusted to obtain favorable conditions for regeneration of the NOx trap.

These features and advantages of the presently claimed invention are not taught or suggested in Tashiro, in which the multistage pilot injections is disclosed only in relation to the "ignitionability" factor, which requires the pilot injections at and after the TDC. Further, Digeser fails to remedy the deficiencies of Tashiro. Therefore, the presently claimed invention is not anticipated by, and not obvious over, Tashiro.

In addition, with respect to the dependent claims, it is submitted that the combined features of these respective claims are not taught or suggested in Tashiro, and that Digeser fails to remedy these deficiencies.

In particular, with respect to claim 2, it is submitted that the cited references fail to teach or suggest controlling the gas admission means to reduce the quantity of gas admitted into the engine when said engine is in its regeneration mode of operation, as recited in present claim 2. An advantage of this feature is that the reduction of the amount of gases admitted into the engine can also contribute to the passage to rich mode (i.e., the O_2 content of the mixture can be reduced).

Also, with respect to claim 5, it is submitted that the cited references fail to teach or suggest regulating the operation of exhaust recirculation means during operation of the engine with a rich mixture, as recited in present claim 5. An advantage of this feature is that an increase

of the exhaust gas recirculation (EGR) can contribute to the passage to rich mode (i.e., burned gases reintroduced into the cylinders have a low O2 content).

Therefore, each of the dependent claims, and in particular, each of claims 2 and 5, is not anticipated by Tashiro, and is not obvious over Tashiro taken alone or in any combination with Digeser.

In view of the above, it is submitted that the rejections should be withdrawn.

In conclusion, the invention as presently claimed is patentable. It is believed that the claims are in allowable condition and a notice to that effect is earnestly requested.

In the event there is, in the Examiner's opinion, any outstanding issue and such issue may be resolved by means of a telephone interview, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

In the event this paper is not considered to be timely filed, the Applicants hereby petition for an appropriate extension of the response period. Please charge the fee for such extension and any other fees which may be required to our Deposit Account No. 502759.

Respectfully submitted,

/nicolas seckel/

Nicolas E. Seckel
Attorney for Applicants
Reg. No. 44,373

Nicolas E. Seckel
Patent Attorney
1250 Connecticut Avenue NW Suite 700
Washington, DC 20036
Tel: (202) 669-5169
Fax: (202) 822-1257
Customer No.: 29980
NES/rep